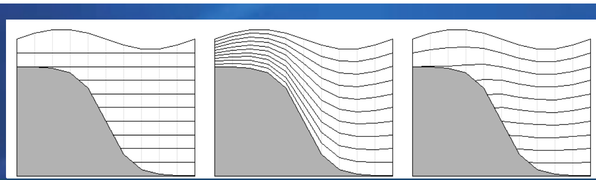
GFDL & MOM

GFDL Institutional Commitment

GFDL is institutionally committed to realizing a numerical ocean model tool of highest scientific and engineering integrity and utility, with MOM being that tool. The primary scientific applications of MOM at GFDL concern mechanistic ocean research and dynamical ocean predictions, with these areas providing a focus for ongoing development.

GFDL Scientific Leadership Provides

- Intellectual vision for MOM's evolution required to retain its position at the leading-edge of numerical ocean models, meeting the needs of global and regional ocean climate science and prediction;
- Scientifically vetted configurations (e.g., CM2.1, ESM2M, CM2.5-ocean) for use by the broader scientific and operational communities;
- Development of numerical methods and physical parameterizations that enhance simulation integrity, fidelity, and utility;
- Software engineering to meet the needs of evolving computational hardware;
- Scientific and engineering documentation via peer-review articles and technical manuals;
- Coordination of contributions from the broader MOM community.



Characteristics of MOM5

Hydrostatic primitive equation ocean code

- Primary GFDL application is global ocean climate science, now moving into the global mesoscale eddy resolving regime (other talks today).
- Generalized level coordinates (z,z*,p,p*) in vertical with B-grid horizontal
- Regional and operational applications (e.g., Australian BlueLink)
- Extensive online diagnostic features (many 100s of diagnostics)
- Freely available under GNU public license

MOM is the world's primary community ocean climate code

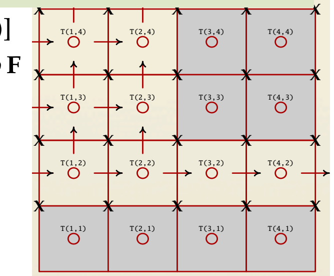
- ~500 registered users of MOM4 and a growing list for MOM5
- Hundreds (thousands) use (used) earlier MOMs
- Open source release of MOM5 via mom-ocean.org

MOM Development and Use: 3-way interaction

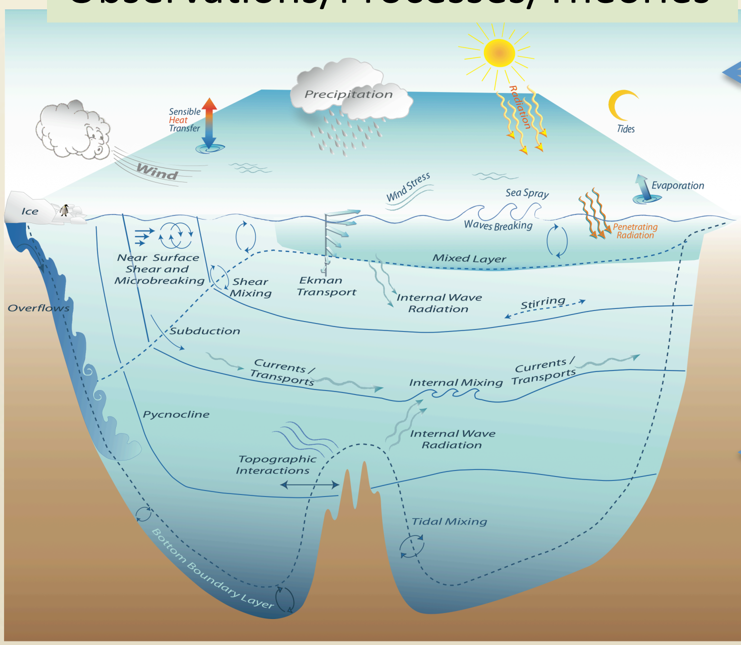
Numerical Methods and Parameterizations

$$
\begin{aligned}
[\partial_t + (f + \mathcal{M})\,\hat{\mathbf{z}} \wedge\,](\mathrm{d}z\,\rho\,\mathbf{u}) = {} & \rho\,\mathrm{d}z\,\mathcal{S}^{(\mathbf{u})} - \nabla_s \cdot [\,\mathrm{d}z\,\mathbf{u}\,(\rho\,\mathbf{u})] \\
& - \mathrm{d}z\,(\nabla_s\, p + \rho\,\nabla_s \Phi) + \mathrm{d}z\,\rho\,\mathbf{F} \\
& - [\,\rho\,(w^{(z)}\,\mathbf{u} - \kappa\,\mathbf{u}_{,z})\,]_{s=s_{k-1}} \\
& + [\,\rho\,(w^{(z)}\,\mathbf{u} - \kappa\,\mathbf{u}_{,z})\,]_{s=s_k}
\end{aligned}
$$

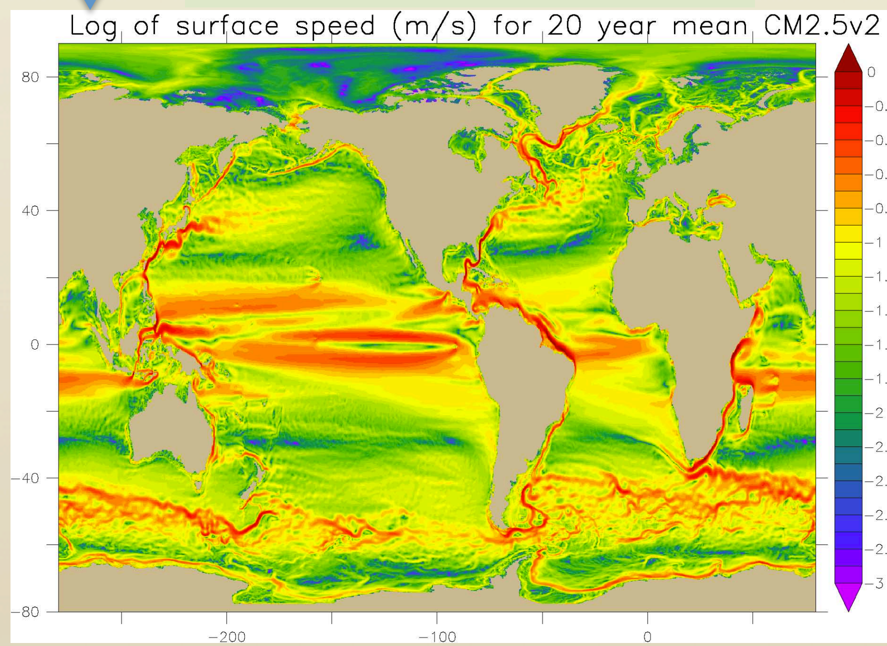
$$
\begin{aligned}
\partial_t(\mathrm{d}z\,\rho\,C) = {} & \mathrm{d}z\,\rho\,\mathcal{S}^{(C)} - \nabla_s \cdot [\mathrm{d}z\,\rho\,(\mathbf{u}\,C + \mathbf{F})] \\
& - [\rho\,(w^{(z)}\,C + F^{(s)})]_{s=s_{k-1}}
\end{aligned}
$$



Observations/Processes/Theories



Simulations and Analyses



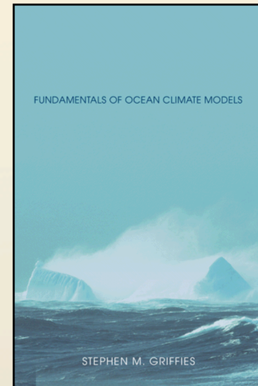
MOM Documentation and Support

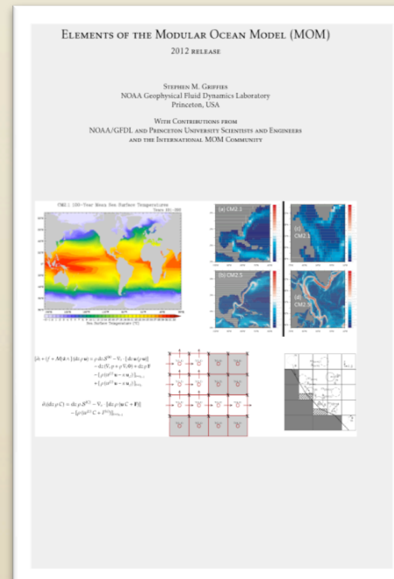
Well understood/trusted simulations of high integrity

- Huge repository of research/operational experience & documentation/publications (we are nearly 50 years since Bryan (1963) initiated ocean modeling at GFDL!)
- GFDL commitment/sanction & community support/participation

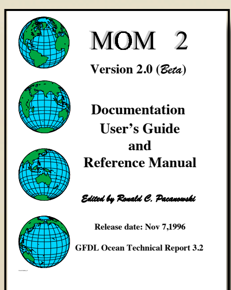
Easy to use for many applications

- New configurations readily developed
- Numerous test cases from idealized to global coupled climate
- Multiple state-of-science methods and parameterizations
- Extensive user community extending over multiple generations





618 + xiii pages



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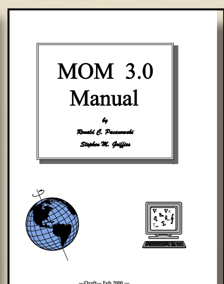

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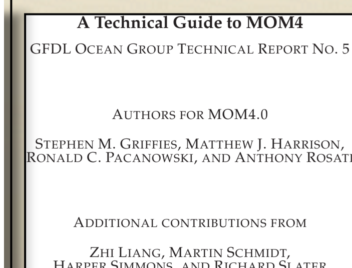

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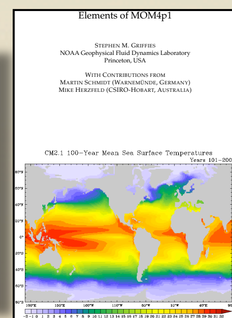

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MOM code status and plans

MOM5

- Released October 2012
- Web site and active online community: mom-ocean.org
- ~15 test cases including CM2.1 (IPCC AR4) and ESM2M (IPCC AR5)
- Open access with community contributions
- Online user/developer community with shared intellectual resources

MOM6 (also see Ram's last slide)

- Built from selected physics/numerics based on experience from the GFDL-GOLD ocean code (Generalized Ocean Layer Dynamics) and MOM5.
- Software restructured to enable MOM/GOLD algorithm unification, and to utilize emerging heterogeneous computer hardware.
- Commitment to MOM6 being a community code, following in the MOM lineage.

Note: GFDL is incorporating the Los Alamos sea ice model, CICE, for its climate modeling, thus aligning GFDL to the broader sea ice community.

MOM6: A Vision for MOM Evolution

GFDL is engaged in a multi-year project to unify capabilities from MOM5 with GFDL's generalized layered ocean model, GOLD.

- MOM6 is motivated by ocean/climate science challenges:
  - Wide range of time scales – seasonal to decadal to centennial
  - Wide range of space scales – e.g., mesoscale eddy resolving for global climate
  - Increasingly comprehensive – e.g., coupling to biogeochemistry, ecosystem, and ice shelf models
- MOM6 will employ state-of-the-science numerical methods and physical parameterizations that are key to, for example,
  - respecting the integrity of ocean water-masses
  - capturing transient climate fluctuations
  - predicting climate variations
  - projecting future climate change
- MOM6 will incorporate GOLD's functionality for generalized vertical layers, and will retain a direct link to scientifically important MOM configurations.